

Amendments to the Claims:

The following listing of claims will replace all prior versions, and listings, of claims in the application:

1. (Currently Amended) An optical information recording apparatus for recording information in an optical information recording medium having ~~a~~ reflecting layer and ~~an~~ information recording layer in which information recorded utilizing holography in the form of an interference pattern as a result of interference between information light carrying two dimensional digital pattern information and reference light for recording having a spatial modulation for, the apparatus comprising:

an information light generating means for generating the information light carrying the two dimensional digital pattern information;

a recording reference light generating means including modulation means for spatially modulating the light, for generating the reference light for recording being spatially modulated by the modulation means; and

a recording optical system, for illuminating the information recording layer on ~~the~~ a same side thereof with the information light and the reference light for recording such that the information is recorded in the form of an interference pattern as a result of using the reflecting layer as a reference plane to generate interference between the information light and the reference light for recording;

wherein the recording optical system projects the information light and the reference light for recording such that an optical axis of the information light and an optical axis of the reference light for recording are located on ~~the~~ a same line.

2. (Currently Amended) The optical information recording apparatus according to claim 1, wherein the optical information recording medium has a positioning layer for recording information for positioning the information light and the reference light for

recording, the apparatus further comprising position control means for controlling the positions of the information light and the reference light for recording relative to the optical information recording medium using the information recorded in the positioning layer.

3-5. (Canceled)

6. (Currently Amended) An optical information recording method for recording information in an optical information recording ~~in an optical information recording~~ medium having reflecting layer and ~~an~~ information recording layer in which information recorded utilizing holography in the form of interference pattern as a result of interference between information light carrying ~~the~~ two dimensional digital pattern information and reference light for recording having spatial modulation, the method comprising ~~the steps of:~~

generating the information light carrying the two dimensional digital pattern information;

spatially modulating the reference light for recording; and

illuminating the information recording layer on ~~the~~ a same side thereof with the information light and the reference light for recording located on ~~the~~ a same line to record the two dimensional digital pattern information in the information recording layer in the form of an interference pattern as a result of using the reflecting layer as a reference plane to generate interference between the information light and the reference light for recording.

7. (Currently Amended) An optical information reproducing apparatus for reproducing two dimensional digital pattern information utilizing holography from an optical recording medium having ~~a~~ reflecting layer and information recording layer in which the information recorded in the form of interference pattern as a result of interference between information light carrying the two dimensional digital pattern information and reference light for recording having a spatial modulation, the apparatus comprising;

a reproduction reference light generation means including modulation means for spatially modulating the light for generating reference light for reproduction, the modulation means spatially modulating the reference light for reproduction in the same manner in which the reference light for recording was modulated when the information was recorded;

a reproducing optical system, for illuminating the information recording layer with the reference light for reproduction on ~~the~~ a same side of the information recording layer that is illuminated with the information light and the reference light for recording and for collecting reproduction light carrying the two dimensional digital pattern information on the same side of the information recording layer that is illuminated with the reference light for reproduction; and

a detecting means for detecting the reproduction light carrying the two dimensional digital pattern information collected by the reproduction optical system;

wherein the reproduction optical system projects the reference light for reproduction onto the reflecting layer and collects the reproduction light such that an optical axis of the reference light for reproduction and an optical axis of the reproduction light are located on ~~the~~ a same line.

8. (Currently Amended) The optical information reproducing apparatus according to claim 7, wherein the optical information recording medium has a positioning layer for recording information for positioning the reference light for reproduction, the apparatus further comprising position control means for controlling the position of the reference light for reproduction relative to the optical information recording medium using the information recorded in the positioning layer.

9-15. (Canceled)

16. (Currently Amended) An optical information reproducing apparatus for reproducing two dimensional digital pattern information utilizing holography from an optical

recording medium having a reflecting layer and information recording layer in which the information recorded in the form of interference pattern as a result of interference between information light having a wavelength selected from among a plurality of wavelengths and carrying the two dimensional digital pattern information and reference light for recording having the wavelength selected from among a plurality of wavelengths, the apparatus comprising;

a wavelength selection means for selecting a wavelength of light illuminating the information recording layer from among a plurality of wavelengths;

a reproduction reference light generation means for generating reference light for reproduction, having the wavelength selected by the wavelength selection means, said reproduction reference light generation means including modulation means for spatially modulating the ~~reproduction~~-reference light for reproduction in the same manner in which the reference light for recording was modulated when the information was recorded;

a reproducing optical system, for illuminating the information recording layer with the reference light for reproduction on a same side of the information recording layer that is illuminated with the information light and the reference light for recording and for collecting reproduction light on the same side of the information recording layer that is illuminated with the reference light for reproduction; and

a detection means for detecting the reproduction light carrying the two dimensional digital pattern information collected by the reproducing optical system;

wherein the reproducing optical system projects the reference light for reproduction onto the reflecting layer and collects the reproduction light such that an optical axis of the reference light for reproduction and an optical axis of the reproduction light are located on a same line.

17. (Currently Amended) The optical information reproducing apparatus according to claim 16, wherein the optical information recording medium has a positioning layer for recording information for positioning the reference light for reproduction, the apparatus further comprising position control means for controlling the position of the reference light for reproduction relative to the optical information recording medium using the information recorded in the positioning layer.

18-50. (Canceled)

51. (Currently Amended) An optical information recording and reproducing apparatus for recording information in and reproduction information from an optical information recording medium having a reflecting layer and an information recording layer in which information is recorded utilizing holography, the apparatus comprising;

an information light generator that generates information light by first light based on first information that is carrying first two dimensional digital pattern information;

a recording reference light generator that modulates a second light to generate a reference light for recording based on second information that is carrying second two dimensional digital pattern information;

a recording optical system for illuminating the information recording layer with the information light and the reference light for recording, the information light and the reference light for recording illuminating the information recording layer on a same side such an interference pattern between the information light and the reference light for recording by using the reflecting layer as a reference plane, wherein the recording optical system projects the information light and the reference light for recording such that an optical axis of the information light and an optical axis of reference light for recording are located on a first same line;

a reproduction reference light generator that modulates ~~a~~ light to generate ~~a~~ reference light for reproduction based on the second information;

a reproducing optical system for illuminating the information recording layer with the reference light for reproduction on the same side of the information recording layer that is illuminated with the information light and the reference light for recording and for collecting ~~the~~ reproduction light on the same side of the information recording layer that is illuminated with the reference light for reproduction, wherein the reproducing optical system projects the reference light for reproduction and collects the reproduction light such that an optical axis of the reference light for reproduction and an optical axis of the reproduction light are on a second same line.

52. (Previously Presented) The optical information recording and reproducing apparatus according to claim 51, further comprising:

a position controller that positions the information light and the reference light on the optical information recording medium based on positioning information in the optical information recording medium.

53. (Currently Amended) The optical information recording and reproducing apparatus according to claim 51, wherein the recording reference light generator performs one or more of spatially modulating the second light and phase modulating the second light to generate the reference light for recording.

54. (Currently Amended) An optical information recording and reproducing method for recording information in and reproducing information from an optical information recording medium having ~~a~~ reflecting layer and ~~an~~ information recording layer in which information is recorded utilizing holography in the form of an interference pattern as a result of interference between information light carrying the two dimensional digital pattern

information and reference light for recording having a spatial modulation, the method comprising:

generating the information light carrying the two dimensional digital pattern information;

~~generating reference light;~~

~~modulating the light to generate the reference light for recording;~~

illuminating the information recording layer with the information light and modulated reference light for recording on the a same side of the optical information recording medium such that an optical axis of the information light and an optical axis of the reference light for recording are on ~~the a~~ same line;

recording the information in the information recording layer as a result of using the reflected layer as a reference plane to generate an interference pattern between the information light and the ~~modulated~~ reference light for recording;

spatially modulating the light to generate reference light for reproduction having a spatial modulation in the same manner in which the reference light for recording was modulated when the information was recorded;

illuminating the information recording layer with the reference light for reproduction on the same side of the information recording layer that illuminated with the information light and the ~~modulated~~ reference light for recording and collecting reproduction light generated at the information recording layer when illuminated with the reference light for reproduction on the same side of the information recording layer that illuminated with the reference light for reproduction such that an optical axis of the reference light for reproduction and an optical axis of the reproduction light are located on a same line; and

detecting the collected reproduction light.

55. (Previously Presented) The optical information recording and reproducing method according to claim 54, wherein the modulating is one or more of spatially modulating and phase modulating.

56. (Currently Amended) An optical information reproduction apparatus for reproducing information utilizing holography from an optical information recording medium having ~~a~~-reflecting layer and ~~an~~-information recording layer in which the information is recorded in the form of interference pattern between information light carrying ~~the two~~ dimensional digital pattern information and reference light, the apparatus comprising:

a reference light generator that spatially modulates the light to generate reference light on the same manner in which the reference light was modulated during recording; and

a reproducing optical system that illuminates, to a same side of the information recording layer that illuminated with the information light and reference light during recording, the information recording layer with the reference light, and collects reproduction light emanating from the information recording layer;

wherein the reproduction optical system projects the reference light and collects the reproduction light such that an optical axis of the reference light and an optical axis of the reproduction light are located on a same line.

57. (Canceled)

58. (Previously Presented) the optical information reproducing apparatus according to claim 56, further comprising a position controller that positions the reference light on the optical information recording medium based on position information in the optical information recording medium.

59. (Currently Amended) An optical information recording and reproducing apparatus for recording information in an optical information recording medium having reflecting layer and information recording layer in which information recorded utilizing

holography and for reproducing the information from the optical information recording medium, the apparatus ~~comprising~~ including a pick-up device ~~having~~ comprising:

a light source for emitting light;

~~a~~ an information light generator that spatially modulates a first portion of light that is carrying two dimensional digital information, based on the information;

a reference light generator including modulation means that generates a first reference light for recording and a second reference light for reproduction from a second portion of the light, wherein the modulation means spatially modulates the second reference light for reproduction in ~~a~~ the same manner in which the first reference light for recording was modulated when the information was recorded; and

an optical system, that illuminates ~~the side of~~ the information recording layer with the information light and the first reference light wherein an optical axis of the information light and an optical axis of the first reference light are on ~~the~~ a same line, to record the information in the information recording layer by using the reflecting layer as a reference plane to generates an interference pattern between the information light and the first reference light, and illuminates the information recording layer with the second reference light on the same side of the information recording layer that is illuminated with the information light and the first reference light and collects reproduction light emanating from ~~the side of~~ the information recording layer when illuminated with the second reference light.

60. (Currently Amended) The optical information recording and reproducing apparatus according to claim 59, wherein the ~~first~~ second reference light is one or more of spatially modulated in substantially a same way a reference light used to record the information that is to be reproduced.

61-78. (Canceled)

79. (Currently Amended) An optical information recording and reproducing apparatus for recording information in and reproducing information from an optical information recording medium having a reflecting layer and an information recording layer in which information is recorded utilizing holography in the form of an interference pattern as a result of interference between information light carrying the two dimensional digital pattern information and reference light for recording having a spatially modulation, the apparatus comprising;

an information light generator unit control to generate plural information light each of which carries corresponding two dimensional digital pattern information;

a recording reference light generation unit, including a modulator for spatially modulating a light, configured to generate plural reference lights for recording each of which is spatially modulated by said modulator in response to a unique phase modulation pattern for said each two dimensional digital pattern information;

an optical recording unit configured to illuminate said information recording layer with said plural information lights and said plural reference lights for recording so that an optical axis of each information light and an optical axis of the corresponding reference light for recording are located on ~~the~~ a same line, to perform a multiplex recording to record on a same location of said optical information recording medium information in the form of plural interference patterns as a result of using the reflecting layer as a reference plane to generate interferences between said plural information lights and said plural reference lights for recording;

a reproduction reference light generation unit, including a modulator for spatially modulating the light, configured to generate plural reference lights for reproduction each of which is spatially modulated ~~by said modulator~~ by said modulator of the reproduction reference light generation unit in response to a unique phase modulation pattern for said each

two dimensional digital pattern information in the same manner in which the reference light for recording was modulated when the information was recorded;

an optical reproducing unit configured to illuminate the information recording layer with the reference light for reproduction generated by the reproduction reference light generation unit on the same side of the information recording layer that is illuminated with the corresponding information light and corresponding reference light for recording and ~~for to~~ collecting reproduction light generated at the information recording layer when illuminated with the reference light for reproduction on the same side of the information recording layer that is illuminated with the reference light for reproduction; and

a detection unit for detecting the reproduction light collected by the optical ~~reproducing unit~~ reproduction system.

80. (Previously Presented) The optical information recording and reproducing apparatus according to claim 79, wherein said optical recording unit performs said multiplex recording so that recording locations adjoining each other are overlapped in part in a certain direction on said optical information recording medium.

81. (Currently Amended) The optical information recording and reproducing apparatus according to claim 79, wherein said optical recording unit records a same interference pattern on plural location of said optical information recording medium.

82. (Currently Amended) The optical information recording and reproducing apparatus according to claim 79, further comprising:

a two dimensional digital pattern information generation unit configured to generate said two dimensional digital pattern information by dividing information to be recorded into plural pieces of data,

wherein said optical recording unit performs said multiplex recording of said plural interference patterns spreading over plural locations on said optical information recording medium in a predetermined order.

83. (Currently Amended) The optical information recording and reproducing apparatus according to claim 82, further comprising:

a parity generation unit configured to generate parity data based on said two dimensional digital pattern information,

wherein said optical recording unit records on said parity data based on a predetermined rule.

84. (Currently Amended) The optical information recording and reproducing apparatus according to claim 83,

wherein said parity generation unit generates plural sets of parity data corresponding to plural sets of two dimensional digital pattern information, and

said optical recording unit records all interference pattern corresponding to said plural sets of parity data on one location on said optical information recording medium.

85. (Currently Amended) The optical information recording and reproducing apparatus according to claim 83,

wherein said parity generation unit generates plural sets of parity data corresponding to plural sets of said two dimensional digital pattern information, and

said optical recording unit records plural interference patterns corresponding to said plural sets of parity data spreading over plural locations, each of which includes an interference pattern corresponding to at least one of said plural sets of parity data.

86-95. (Canceled)

96. (Currently Amended) The optical information recording apparatus of claim 1, wherein the recording optical system includes only one objective lens for projecting the

information light generated by the information light generation means and the reference light for recording generated by the recording reference light generation means upon the optical information recording medium.

97. (New) An optical information recording apparatus for recording information which is two dimensional digital pattern information, utilizing holography in an optical information recording medium having reflecting layer and information recording layer, the apparatus comprising:

a servo light source that generates servo light which emits onto the reflecting layer;

a detection means for detecting reflected servo light which is carrying information of the medium, reflected by the reflecting layer, such that an optical axis of the servo light and an optical axis of the reflected servo light are located on a same line;

an information light source that generates information light carrying the information that is two dimensional digital pattern information based on the information of the medium;

a recording reference light source that generates recording reference light, including a modulator that spatially modulates the recording reference light; and

a recording optical system that projects the information light and the recording reference light such that an optical axis of the information light and an optical axis of the recording reference light are located on the same line.

98. (New) An optical information reproducing apparatus for reproducing two dimensional digital pattern information recorded utilizing holography in an optical information recording medium having reflective layer and optical recording layer, the apparatus comprising:

a servo light source that generates servo light that emits onto the reflecting layer;

a detection means for detecting reflected servo light that is carrying information of the medium, reflected by the reflecting layer, such that an optical axis of the servo light and an optical axis of the reflected servo light are located on a same line;

a reproduction reference light source that generates reproduction reference light, including a modulator that spatially modulates the reproduction reference light; and

a reproducing optical system that projects the reproduction reference light and collects reproduction light such that an optical axis of the reproduction reference light and an optical axis of the reproduction light are located on a same line.

99. (New) The optical information reproducing apparatus according to claim 98, further comprising:

a wavelength selector that selects a wavelength from among a plurality of wavelength.

100. (New) An optical information recording apparatus for recording information in an optical information recording medium having reflecting layer and information recording layer in which information is recorded utilizing holography in the form of an interference pattern as a result of interference between information light carrying the information and reference light for recording having a spatial modulation for, the apparatus comprising:

a servo light generating means for generating servo light that emits onto the reflecting layer;

a reflected servo light detecting means for detecting reflected servo light which is reflected by the reflecting layer of the medium;

an information light generating means for generating the information light carrying the information which is based on information of the optical information recording medium;

a recording reference light generating means including modulation means for spatially modulating the light, for generating the reference light for recording being spatially modulated by the modulation means; and

a recording optical system, for illuminating the information recording layer on the first side thereof with the information light and the reference light for recording such that the information is recorded in the form of an interference pattern as a result of using the reflecting layer as a reference plane to generate interference between the information light and the reference light for recording,

wherein the recording optical system projects the servo light and collects the reflected servo light which is carrying the information of the medium, reflected by the reflecting layer such that an optical axis of the servo light and an optical axis of the reflected servo light are located on a same line; and

the recording optical system further projects the information light and the reference light for recording such that an optical axis of the information light and an optical axis of the reference light for recording are located on the same line.

101. (New) An optical information recording method for recording two dimensional digital pattern information in an optical information recording medium having reflecting layer and information recording layer in which information recorded utilizing holography in the form of interference pattern as a result of interference between information light carrying the two dimensional digital pattern information and reference light for recording having spatial modulation, the method comprising:

generating a servo light;

illuminating the servo light onto the reflecting layer on a first side thereof;

detecting reflected servo light reflected by the reflecting layer of the optical information recording medium, carrying the information of the recording medium;

generating the information light carrying the two dimensional digital pattern information which is based on information of the optical information recording medium;

spatially modulating the reference light for recording; and

illuminating the information recording layer on the first side thereof with the information light and the reference light for recording both located on the same line to record the information in the information recording layer in the form of an interference pattern as a result of using the reflecting layer as a reference plane to generate interference between the information light and the reference light for recording.

102. (New) An optical information reproducing apparatus for reproducing information utilizing holography from an optical recording medium having reflecting layer and information recording layer in which two dimensional digital pattern information is recorded in the form of interference pattern as a result of interference between information light carrying the two dimensional digital pattern information and reference light for recording having a spatial modulation, the apparatus comprising;

a servo light source that generates a servo light to illuminate onto the reflecting layer;

a reflected servo light detection means for detecting reflected servo light that is carrying the information of the medium, reflected by the reflecting layer such that an optical axis of the servo light and an optical axis of the reflected servo light are located on a same line;

a reproduction reference light generation means including modulation means for spatially modulating the light, for generating reference light for reproduction, the modulation means spatially modulating the reference light for reproduction in the same manner in which the reference light for recording was modulated when the information was recorded;

a reproducing optical system, for illuminating the information recording layer with the reference light for reproduction on the same side of the information recording layer that is illuminated with the information light and the reference light for recording and for collecting reproduction light carrying the two dimensional digital pattern information on the same side

of the information recording layer that is illuminated with the reference light for reproduction;
and

a detection means for detecting the reproduction light carrying the two dimensional digital pattern information collected by the reproduction optical system,

wherein the reproduction optical system projects the reference light for reproduction and collects the reproduction light such that an optical axis of the reference light for reproduction and an optical axis of the reproduction light are located on a same line.

103. (New) An optical information recording and reproducing apparatus for recording information in and reproducing information from an optical information recording medium having reflecting layer and information recording layer in which information is recorded utilizing holography in the form of an interference pattern as a result of interference between information light carrying two dimensional digital pattern information and reference light for recording having a spatially modulation, the apparatus comprising;

a servo light generator generates servo light for recording that illuminates onto the reflecting layer, the servo light generator generates servo light for reproducing that illuminates onto the reflecting layer;

a detector that detects reflected servo light for recording that is carrying the information of the medium, reflected by the reflecting layer such that an optical axis of the servo light for recording and an optical axis of the reflected servo light for recording are located on a same line, the detector detects reflected servo light for reproducing that is carrying the information of the medium, reflected by the reflecting layer such that an optical axis of the servo light for reproducing and an optical axis of the reflected servo light for reproducing are located on a same line;

an information light generator unit control to generate plural information lights each of which carries corresponding two dimensional digital pattern information, based on the information of the medium;

a recording reference light generation unit, including a modulator for spatially modulating a light, configured to generate plural reference lights for recording each of which is spatially modulated by said modulator in response to a unique phase modulation pattern for said each two dimensional digital pattern information;

an optical recording unit configured to illuminate said information recording layer with said plural information lights and said plural reference lights for recording so that an optical axis of each information light and an optical axis of the corresponding reference light for recording are located on a same line, to perform a multiplex recording to record on a same location of said optical information recording medium information in the form of plural interference patterns as a result of using the reflecting layer as a reference plane to generate interferences between said plural information lights and said plural reference lights for recording,

a reproduction reference light generation unit, including a modulator for spatially modulating the light, configured to generate plural reference lights for reproduction each of which is spatially modulated by said modulator in response to a unique phase modulation pattern for said each two dimensional digital pattern information in the same manner in which the reference light for recording was modulated when the information was recorded;

an optical reproducing unit configured to illuminate the information recording layer with the reference light for reproduction generated by the reproduction reference light generation unit on the same side of the information recording layer that is illuminated with the corresponding information light and corresponding reference light for recording and to collect reproduction light generated at the information recording layer when illuminated with

the reference light for reproduction on the same side of the information recording layer that is illuminated with the reference light for reproduction; and

a detection unit for detecting the reproduction light collected by the optical reproduction system.

104. (New) The optical information recording and reproducing apparatus according to claim 103, wherein said optical recording unit performs said multiplex recording so that recording locations adjoining each other are overlapped in part in a certain direction on said optical information recording medium.

105. (New) The optical information recording and reproducing apparatus according to claim 103, wherein said optical recording unit records a same interference pattern on plural location of said optical recording medium.

106. (New) The optical information recording and reproducing apparatus according to claim 103, further comprising:

a two dimensional digital pattern information generation unit configured to generate said two dimensional digital pattern information by dividing information to be recorded into plural pieces of data,

wherein said optical recording unit performs said multiplex recording of said plural interference patterns spreading over plural locations on said optical information recording medium in a predetermined order.

107. (New) The optical information recording and reproducing apparatus according to claim 106, further comprising:

a parity generation unit configured to generate parity data based on said two dimensional digital pattern information,

wherein said optical recording unit records on said parity data based on a predetermined rule.

108. (New) The optical information recording and reproducing apparatus according to claim 107,

wherein said parity generation unit generates plural sets of parity data corresponding to plural sets of two dimensional digital pattern information, and

said optical recording unit records all interference pattern corresponding to said plural sets of parity data on one location on said optical information recording medium.

109. (New) The optical information recording and reproducing apparatus according to claim 107,

wherein said parity generation unit generates plural sets of parity data corresponding to plural sets of said two dimensional digital pattern information, and

said optical recording unit records plural interference patterns corresponding to said plural sets of parity data spreading over plural locations, each of which includes an interference pattern corresponding to at least one of said plural sets of parity data.